UNITED STATES PATENT APPLICATION FOR:

METHOD AND APPARATUS FOR AN AIR-CAVITY PACKAGE

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METHOD AND APPARATUS FOR AN AIR-CAVITY PACKAGE

CROSS-REFERENCE TO A RELATED APPLICATION

[0001] U.S. Patent application entitled " Method and Apparatus for a Lead-Frame Air-cavity Package", serial number__________ filed on _____________, filed in the name of ***David Lee*** is hereby incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] Embodiments of the invention generally relate to component packaging structures.

Background of the Related Art

[0003] Microelectronic devices typically include one or more die (i.e., micro components formed on a single substrate) having a multitude of die bond pads, a chip body, and an interconnection scheme to connect the pads on the die to a supporting substrate. Generally, the supporting substrate and a package are placed around the die to provide physical protection from contaminates. The combination of these is generally referred to as a "chip package". According to conventional packaging methodologies, the number of interconnects for common component (IC) packages such as a dual-inline package (DIP), single-inline package (SIP), and others, is limited to the perimeter of the package. Generally, a ball grid array (BGA) package style is used to facilitate an increased connection density. The BGA package provides interconnections from the package bottom or top surface, thus increasing the number of potential interconnection points.

[0004] Generally, the ICs increase in speed and performance is directly coupled to an increased device operating frequency. Unfortunately, the device packaging, die, and internal die interconnections provide for potential frequency issues. The increase in device frequency, often in the giga-hertz range, increases the device sensitivity to

parasitic capacitance and inductance. For example, to decrease the height and cost of packaging, device packages are often molded simultaneously to a plurality of individual IC circuits on one substrate. Subsequently, the individual circuits are then cut away from the single substrate using, for example, a high-speed saw to form individual ICs. Unfortunately, as device frequencies increase the type of packaging material used decreases the overall IC performance. To accommodate the higher IC performance, IC manufacturers often use individual ceramic covers having a lower dielectric constant in lieu of a molded package. Unfortunately, to add individual covers is expensive relative to the molded packaging and therefore is often avoided, thereby sacrificing IC performance in devices such as cellular phones. Further, while the individual covers often provide increased device performance, the process of applying the individual covers often damages the ICs they are designed to protect, thereby decreasing IC throughput and increasing IC cost.

[0005] Therefore, what is a needed is a method and apparatus to provide an efficient and a cost effective package for components.

SUMMARY OF THE INVENTION

[0006] Embodiments of the invention provide a method, article of manufacture, and apparatus for providing component packages. In one embodiment, the invention provides bonding a carrier to an enclosure including a plurality of covers having an air-cavity to receive at least one of the components therein, and forming a component package assembly.

[0007] In another embodiment, the invention provides a method of packaging an component, comprising bonding a body comprising a plurality of component covers to a carrier comprising a plurality of the components thereon wherein at least one of the components is positioned proximate one of the component covers, and then providing an air-cavity between each of the components and their respective component covers.

[0008] In another embodiment, the invention provides a component cover, comprising a plurality of separable separateable sidewalls disposed on a top member wherein the separable sidewalls and top member define a plurality of separable individual

component packages to receive components therein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] So that the manner in which the above recited features of the invention are attained and can be understood in detail, a more particular description of the invention, briefly summarized above, may be had by reference to the embodiments thereof which are illustrated in the appended drawings.

[0010] It is to be noted, however, that the appended drawings illustrate only typical embodiments of this invention and are therefore not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

[0011] Figure 1 is a top view of one embodiment of a cover assembly including a plurality of individual component packages.

[0012] Figure 2 is a bottom view of one embodiment of a cover assembly including a plurality of individual component packages.

[0013] Figure 3 is a perspective view of one embodiment of a cover assembly and a plurality of individual component packages mounted on a carrier in position for assembly.

[0014] Figure 4 is a top view of one embodiment of an assembled cover assembly and carrier.

[0015] Figure 5 is a cross sectional view of one embodiment of an assembled cover assembly and carrier of Figure 4.

[0016] Figure 6 is a perspective view partially in cross-section of one embodiment of an individual component package detached from the assembled cover assembly and carrier of Figure 4.

[0017] Figure 7 is a flow diagram of a process of forming component packages.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] Embodiments of the invention provide a method, article of manufacture, and apparatus for providing component packages. As used herein "package" includes any device package such as a package for components (i.e., ICs) having air as the

dielectric regardless of package material. Furthermore, as used herein "components" refers to any device or circuit element such as an integrated circuit device having integrated electrical circuits that may include a plurality of dies integrated together within a device package and/or components such as resistors, capacitors, and inductors.

[0019] As will be described below, aspects of one embodiment pertain to specific method steps implementable on computer systems such as a conventional process controller (not shown). In general, the processing system controller may include a controller such as programmable logic controller (PLC) or computer. The process controller 118 may include a central processing unit (CPU) including a memory. The memory may contain a component assembly control program that, when executed by the CPU, provides support for controlling the component assembly. The component assembly control program conforms to any one of a number of different programming languages. For example, the program code can be written in PLC code (*e.g.,* ladder logic), C, C++, BASIC, Pascal, or a number of other languages. In one embodiment, the invention may be implemented as a computer program-product for use with a computer system. The programs defining the functions of at least one embodiment can be provided to a computer via a variety of computer-readable media (*i.e.,* signal-bearing medium), which include but are not limited to, (i) information permanently stored on non-writable storage media (e.g. read-only memory devices within a computer such as read only CD-ROM disks readable by a CD-ROM or DVD drive; (ii) alterable information stored on a writable storage media (e.g. floppy disks within diskette drive or hard-disk drive); or (iii) information conveyed to a computer by communications medium, such as through a computer or telephone network, including wireless communication. The latter specifically includes information conveyed via the Internet. Such signal-bearing media, when carrying computer-readable instructions that direct the functions of the invention, represent alternative embodiments of the invention. It may also be noted that portions of the product program may be developed and implemented independently, but when combined together are embodiments of the invention.

[0020] Figures 1 and 2 are a top view and bottom view respectively of one embodiment of a cover assembly 100 including a plurality of individual component package covers. The cover assembly 100 includes a plurality of sidewalls 102 extending from a top portion 104. The sidewalls 102 extend from the top portion 104 in a general grid pattern to define a plurality of component covers 108 having an air-cavity 110 to receive components such as components (*i.e.* ICs), capacitors, resistors, inductors, and other similar components, therein. The cover assembly 100 is formed of conventional materials such as polymers, ceramics, glass, and the like, adapted to provide the components protection from external damage and contamination. It is contemplated that the cover assembly 100 may be molded or formed using techniques such as thermoplastic injection, molding, casting, and other molding techniques. The top 104 includes a plurality of vent holes 105 to allow for the escape of water and other contaminates that may off-gas during assembly. In one aspect, the vent holes 105 are sealed after assembly using a sealant such as a rubber, plastic, and/or other sealing materials, to prevent contamination from entering the air-cavity 110. In one aspect, the sidewalls 102 are arranged to form the plurality of component covers 108 in a generally rectangular shape but may be arranged to form any desired shape such as square, quadrilateral, trapezoidal, and the like. For example, the sidewalls 102 may be circular in shape to accommodate generally round components. In one aspect, the sidewalls 102 may be formed with an inverted bevel to allow the mold to be more easily removed after the sidewalls 102 are formed.

[0021] Figure 3 is a perspective view of one embodiment of a cover assembly 100 and a plurality of components and/or individual component dies 112 mounted on a carrier 111 in position for assembly together. The carrier 111 may be formed of any circuit board material such as fiberglass. The cover assembly 100 is generally aligned with each component die 112 to allow at least one component and/or component die 112 to fit between the sidewalls 102 and within a respective the air-cavity 110. For example, as illustrated, the sidewalls 102 may be configured to fit between a plurality of component dies 112 and disposed adjacent an exposed portion of the carrier 111. In one embodiment, an adhesive layer 114 of any conventional formulation such as

epoxy, or glue, may be applied to the sidewalls 102 disposed adjacent the carrier 111 and/or to the carrier 111 to bond the sidewalls 102 and the carrier 111 together.

[0022] Figure 4 is a top view illustration of one embodiment of a cover assembly 100 including a plurality of the component covers 108 proximate to and aligned with a component die 112. When assembled, as illustrated in Figure 4, the component dies 112 are disposed within the air-cavities 110 having a gas such as air therein, to form a component package assembly 116 defining a plurality of individual component packages 118. Each individual component package 118 may include at least one component such as component die 112 interconnected to external connection pads 120 on the carrier 111 via bonding pads 122 and vias 124 using interconnection wiring 126. For example, Figure 5 illustrates a cut away view of one embodiment of the component package assembly 116 before separating into the individual component packages 118. As illustrated, the sidewalls 102 and carrier 111 are bonded together by the adhesive layer 114 to form the individual component package 118 to individually enclosure each component die 112. In one embodiment, the internal surfaces of the individual component package 118 include a metallization layer 103 thereon to provide internal and/or external shielding from electromagnetic radiation. In one aspect, the metallization layer 103 may be applied to the cover 100 before assembly using coating techniques such as painting, sputtering, and other techniques used to apply metallization coatings. The sidewalls 102 carrier 111 and adhesive layer 114 are adapted to be separated by a cutting tool (not shown) such as a saw, laser, water cutting tool, milling tool, lath, and the like. The cutting tool is adapted to cut between each sidewall 102 and the adjacent carrier 111 to separate the component package assembly 116 into the individual component packages 118. In one aspect, the height of the component cover 108 is adjusted to allow the internal wiring 126 sufficient space to be mounted to the component die 112 using conventional wiring techniques. Figure 6 is a perspective view in partial cross section illustrating an individual component package 118 after separation from the component package assembly 116 of Figure 4.

[0023] Figure 7 is a flow diagram of a method 700 of forming component packages. As necessary, Figures 1-6 are referenced in the following discussion of Figure 7.

[0024] Figure 7 is entered at step 702 when for example an assembly step for forming component packages is initiated. At step 704, the method 700 uses application processes such as screen-printing, stenciling, and/or other similar processes, to apply the adhesive layer 114 between the cover 100 and the carrier 111. While the adhesive may be applied to the cover 100 and/or to the carrier 111, in order to protect the component dies 112 from damage during the adhesive application, the adhesive layer may be applied to the cover 100 before the cover 100 is assembled to the carrier 111. In one aspect, the adhesive layer may formed as a separate sub-assembly and then disposed on the cover 100 and/or carrier 111. For example, the adhesive layer 114 could be formed from a sheet of adhesive material. One embodiment of the adhesive layer 114 is illustrated with respect to Figure 3. The cover assembly 100 is then aligned with a carrier 111 having a plurality of components such as component dies 112, mounted thereon, and in general alignment with a respective air-cavity 110 at step 706. The alignment of the cover assembly 100 is adjusted by the method 700 at step 708. If the cover assembly 100 is not aligned then the method 700 returns to step 706. If the cover assembly 100 is aligned, then the cover assembly 100 is mounted to the carrier 111 using the adhesive 114 adjacent the component dies 112 to form the component package assembly 116. At step 712, the adhesive layer 114 is cured using conventional techniques such as heating, air curing, and other adhesive curing techniques. When the adhesive curing process is complete, a sealant is applied to the vent holes 105 to seal the air-cavity 110 from contamination at step 714. The sealant is cured at step 716 using conventional techniques such as heating, air curing, and other curing techniques. At step 718, the component package assembly 116 is separated into individual component packages 118. While In one embodiment, the assembly process is performed by conventional assembly tools used to package components such as a component packing apparatus (not shown), or a pick and place robotic tool, it is contemplated that the assembly may be performed by other means such as by hand, or by one or more conventional assembly tools used to package components.

[0025] Although various embodiments which incorporate the teachings of the

invention have been shown and described in detail herein, those skilled in the art can readily devise many other varied embodiments within the scope of the invention. In one embodiment, the sidewalls 102 may be laid out in a variety of different patterns to accommodate different sizes of components. For example, the sidewalls 102 may form one or more package sizes, to accommodate a variety of different sized component packages on the same carrier 111. Thus, a cover assembly 100 may be adapted to accommodate any size, shape, or dimension of the components on the carrier 111.

[0026] In summary, aspects of the invention provide a method 700 of packaging components (e.g. component die 112), including bonding 710 a carrier 111 to an enclosure (e.g., cover assembly 100) including a plurality of covers 108 having an air-cavity 110 to receive at least one of the components therein, then forming 700 a component package assembly 116. In one aspect, the components comprise a component die 112. In another aspect, the enclosure is formed of materials comprising polymers, ceramic, glass, and combinations thereof. In addition, the bonding 710 may include providing 704 an adhesive layer 114 between the enclosure and the carrier 111 wherein providing the adhesive layer 114 between the enclosure and the carrier 111 may include applying an adhesive to the carrier 111. Further, where providing the adhesive layer 114 between the enclosure and the carrier 111 may comprise applying 704 adhesive to a cover 100 surface disposed adjacent the carrier 111. In another embodiment, the method 700 includes separating 718 the component package assembly 116 into individually packaged components 118 where, in one aspect of the invention, separating 718 includes cutting between each of the pluralities of components through a plurality of sidewalls 102 and the carrier 111. The cutting includes various forms of cutting such as sawing, laser cutting, water cutting, milling, machining, lathing, and combinations thereof.

[0027] In another embodiment, the invention provides a method 700 of packaging components, comprising bonding 710 a body (e.g., cover 100) comprising a plurality of component covers 108 to a carrier 111 comprising a plurality of the components (e.g. integrated circuit die 112) thereon wherein at least one of the components is positioned 708 proximate one of the component covers 108, and then providing an air-cavity 110

between each of the components and their respective component covers 108. The method further includes the components comprising a component die 112. In addition, the body may be formed of materials comprising polymers, ceramic, glass, and combinations thereof. In one embodiment, the body comprises sidewalls 102 defining the covers 108 where bonding 710 the body to the carrier comprises providing 704 an adhesive between the sidewalls 102 and the carrier 111. In another embodiment, the method 700 includes separating 718 the sidewalls 102 and adjacent carrier 111 to form individual components 118 having at least one of the covers 108 thereon. In one aspect of the invention, separating 718 comprises sawing the common sidewalls 102 and carrier 111 using a saw, laser cutting tool, water cutting tool, mill, lath, and combinations thereof. In another aspect, providing the air-cavity 110 between each of the components and their respective component covers 108 comprises forming the sidewalls 102 including a top member 104 that exceeds the height of the components where the sidewalls 102 and the top member 104 define the enclosure 100.

[0028] In another embodiment, the invention provides an component cover 100, comprising a plurality of separable sidewalls 102 disposed on a top member 104 wherein the separable sidewalls 102 and top member 104 define a plurality of separable individual air-cavities 110 to receive at least one component (e.g. integrated circuit die 112) therein. In one aspect, at least one of the sidewalls 102 and top member 104 define an individual component enclosure 118.

[0029] While the foregoing is directed to the preferred embodiment of the invention, other and further embodiments of the invention may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims that follow.